Global Horizons

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Outline

- Future Global Environment
- Technology Horizons
- Energy Horizons
- Cyber Vision 2025
- Global Horizons

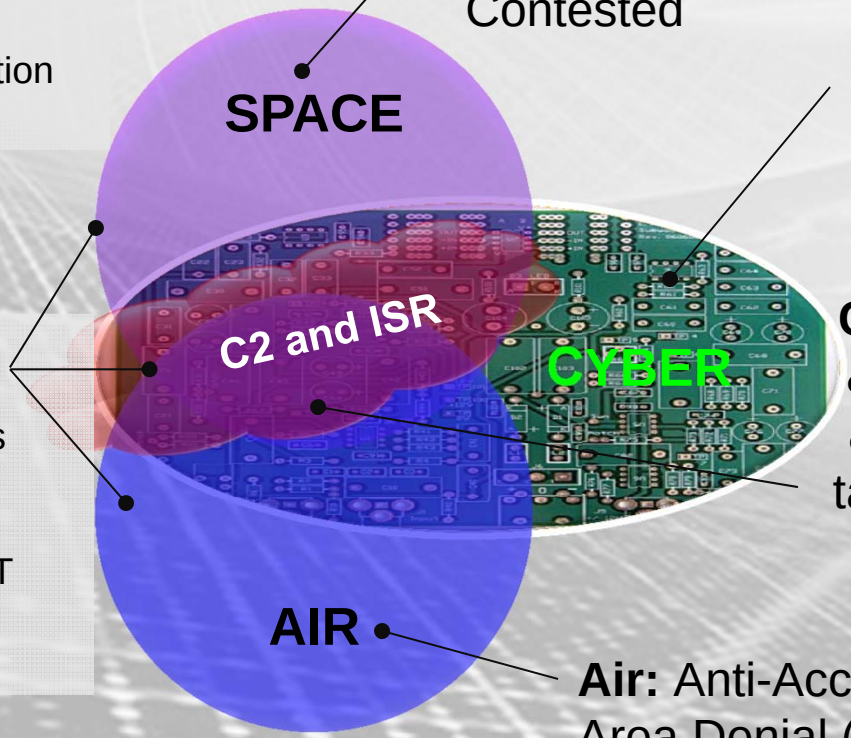
Global Environment

Global Forces

- Demographics
- Climate
- Resources (Natural, Talent, Treasure, Time)
- Globalization/Proliferation
- Conflict

Global Sectors

- Manufacturing and Materials
- Transport and Logistics
- Energy and Utilities
- Health and Pharma
- Communications and IT
- Financial Services
- Education and Training



Space: Congested, Competitive, Contested

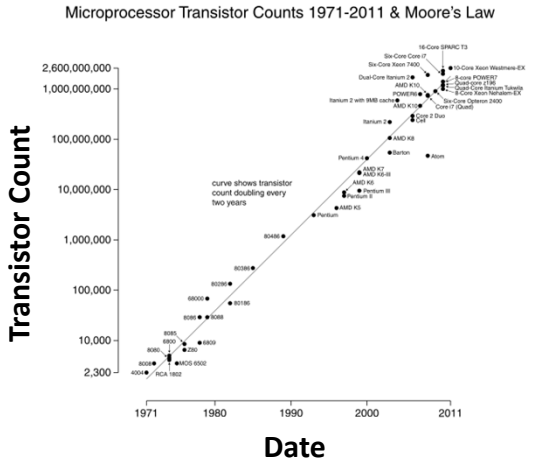
Cyberspace: threatened by malicious insiders, supply chain attacks, and advanced persistent threats to deceive, degrade, disrupt, destroy

Command and Control (C2) & Intelligence Surveillance and Reconnaissance (ISR) targeted as a center of gravity threatening integrated and resilient global operations

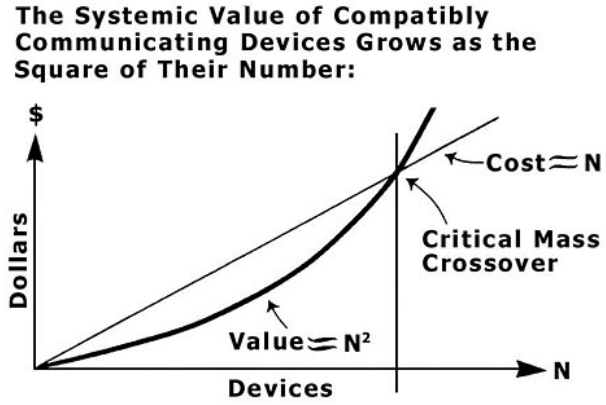
Air: Anti-Access, Area Denial (A2/AD)

Global Vigilance, Reach and Power dependent upon contested Global Domains and Globalized Industrial Sectors

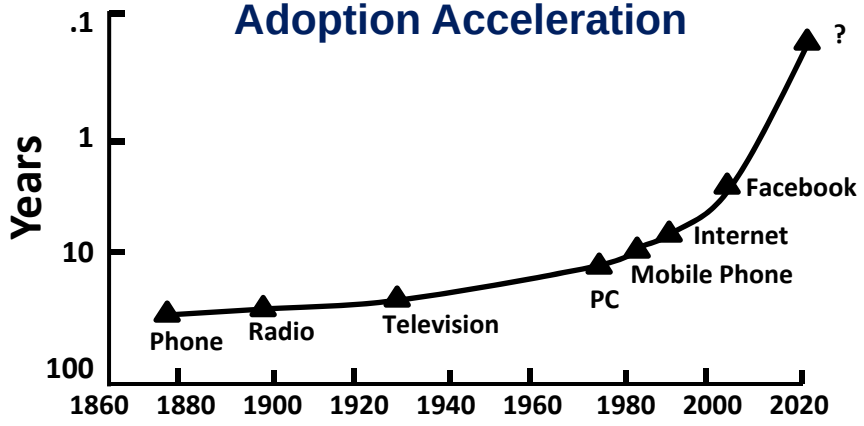
Laws Help Forecast Future



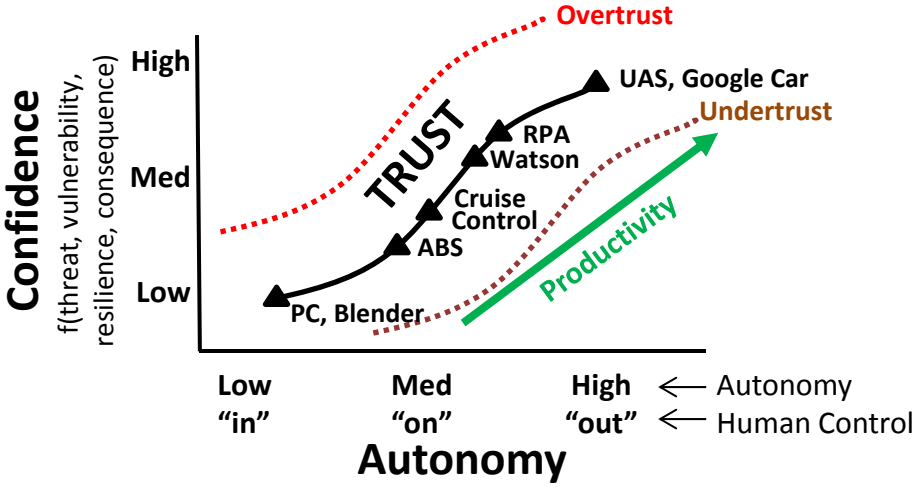
Moore's Law



Metcalf's Law



Kurzweil's Law

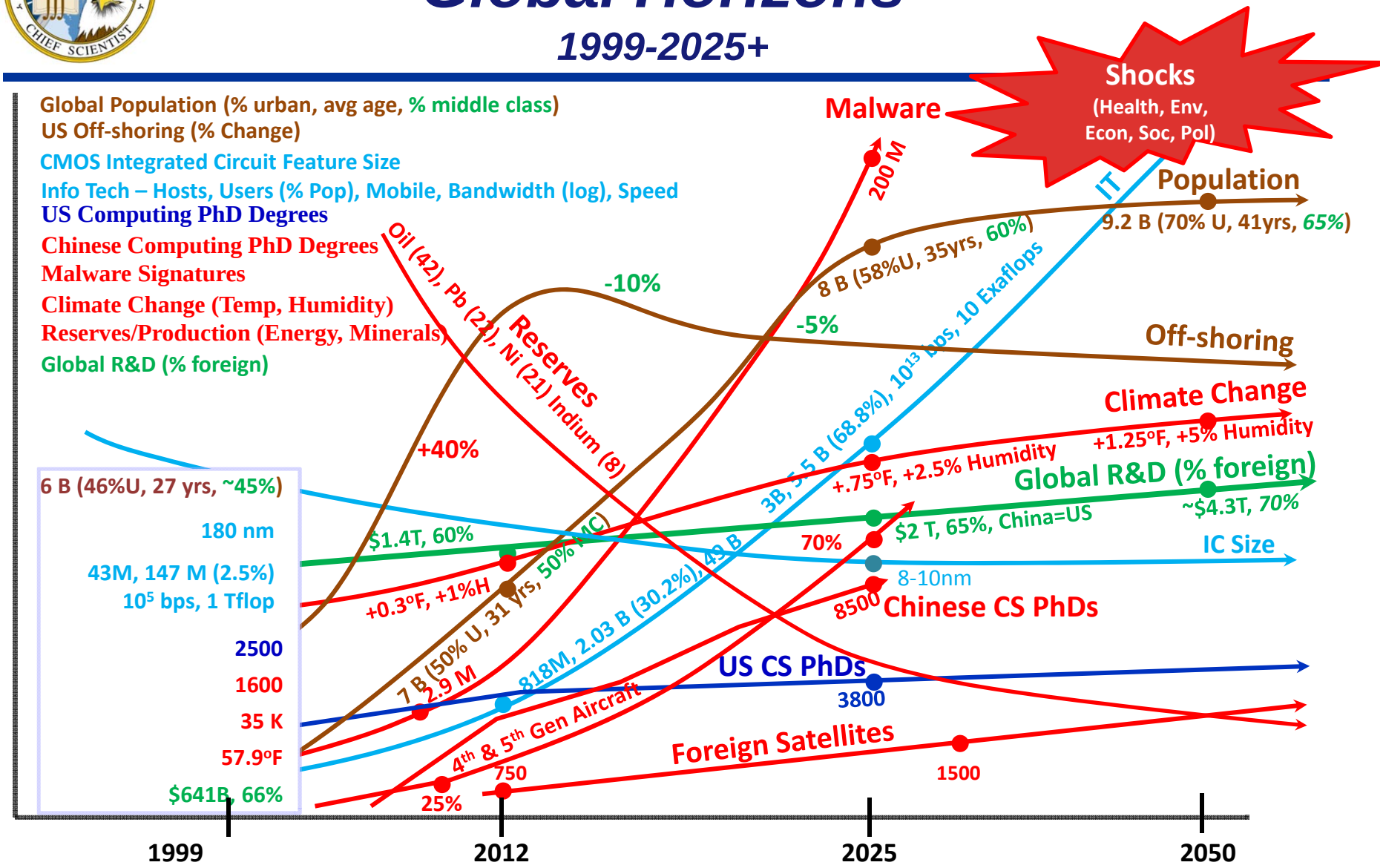


Maybury's Law

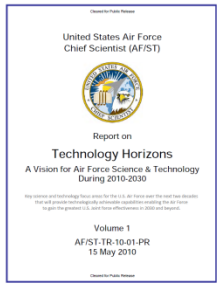
Source: KurzweilAI.net

Global Horizons

1999-2025+



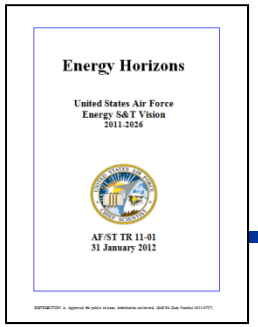
CMOS – Complimentary Metal-Oxide Semiconductor; IC – Integrated Circuit



www.af.mil/information/technologyhorizons.asp

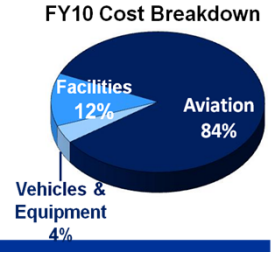
Technology Horizons

- **Strategic, technology and budget environments drive need for capability increases, manpower efficiencies, and cost reductions**
- **Key capability areas (with associated enabling technologies):**
  - **Highly-adaptive autonomous systems (and trust in autonomy)**
  - **Human-machine interfaces and human performance augmentation**
  - **Increased cyber resilience**
  - **PNT in GPS-denied environments**
  - **Electromagnetic spectrum warfare**
  - **Processing-enabled intelligent sensors**
  - **Directed energy for tactical strike/defense**
  - **Next-generation high-efficiency gas turbine engines**
  - **Persistent space situational awareness**
  - **Rapidly composable small satellites**



tinyurl.com/afenergyhorizons

Energy Horizons: Air Force Energy S&T Vision



Energy Horizons Vision

Assured energy advantage across air, space, cyberspace and infrastructure

Findings

- Energy S&T advances can revolutionize cost, readiness, and resiliency
- Air fuels and facilities/data centers primary cost drivers
- Benefits from systems, operations, supply, and culture
- Partnership and S&T leverage essential

Air

Space

Cyber

Infrastructure

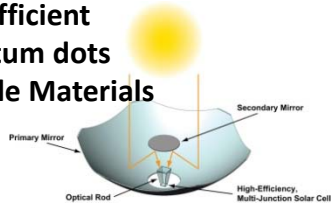
Recommendations

- Mission-focused S&T roles (lead, follow, watch) in near-, mid-, far-term
- *Air*: Efficient engines and structures, distributed virtual training, flight formation
- *Space*: Efficient photovoltaics, efficient ground stations, fractionated constellations
- *Cyber*: Efficient cloud and HPC
- *Infrastructure*: Secure microgrids, Expeditionary energy, small modular nuclear reactors, solar to petrol
- *Enabling*: nanomaterials, biomimicry, autonomy

Cross Cutting Energy Enabling Technologies

Generation

- 70% Efficient
- Quantum dots
- Flexible Materials

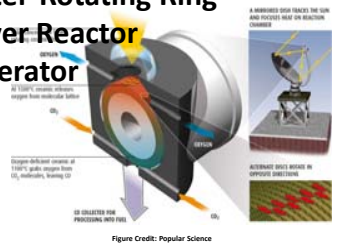


Ultra-Efficient PhotoVoltaics

- Efficient conversion
- Non food sources (e.g., camelina)
- Global supply

BioFuels

- Counter-Rotating Ring Receiver Reactor Recuperator



Sun to Petrol

- Small modular
- <300 MW
- Autosafing
- Waste reuse
- Transportable
- Grid security

Advanced Nuclear

Storage

- 100k discharge cycles
- High power (10MW)
- High energy density (>300 Wh/kg)
- Hours of discharge

Advanced Batteries (Lead Acid, NaS, ZEBRA, Li-Ion)

- High energy (10kW)
- Hours of discharge

Ultra Capacitors

- 100k discharge cycles
- High power (10MW)
- Hours of discharge
- High reliability

High Power Fly Wheels

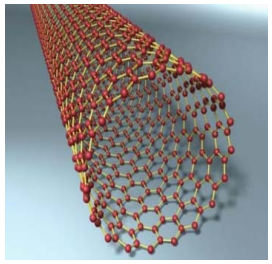
- Increased grid security/reliability
- >95% efficient
- Storage up to 10MW

Superconducting Magnetic Energy

Use

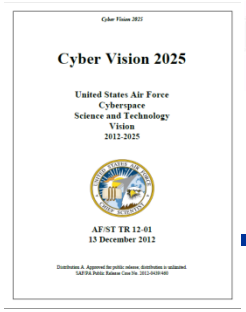
Efficient Cloud and Super Computing

Energy Micromonitoring



- C-C Nanotubes & graphene
- Light strength, tailorable
- thermal and energy storage properties
- Increase lift to weight ratios
- Nanoelectronics for SWAP (nanowires, memristers)

NanoMaterials



1. AF Cyber

tinyurl.com/afcv2025

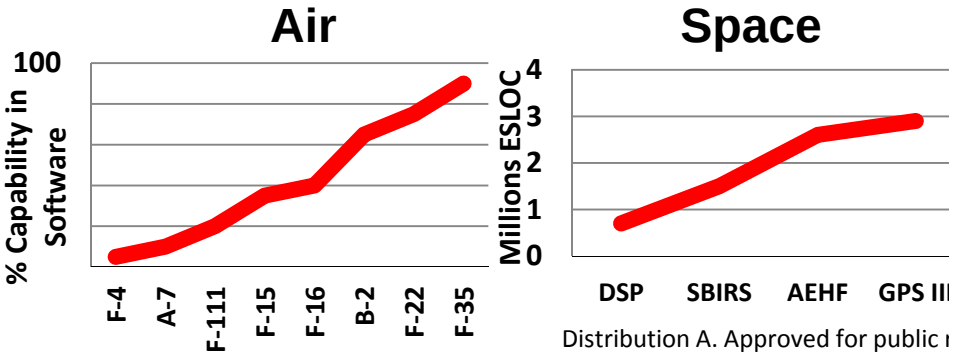
Air Force Cyber Vision 2025

Air Force Cyberspace S&T Vision

Assured cyber advantage across air, space, cyber, C2, ISR, and mission support

Findings

- **Missions at risk: Growing threats (insider, supply chain, advanced) and interdependencies**
- **Cyber S&T enables assurance, resilience, affordability, empowerment**
- **Need to integrate across authorities and domains (cross domain effects)**
- **Need to shape doctrine, policy, people, (RDT&E) processes**
- **Partnership and leverage essential**



Recommendations

- **Assure and Empower the Mission (MAJCOMs)**
  - **Title 10/50/32, Multi-domain synch effects**
- **Improve Cyber Education, Accessions, Training (AETC, A1, A6, AFSPC)**
- **Advance Acquisition and Partnership (AFSPC, AQ, TE, MAJCOMS)**
  - **Require/design in security; secure life cycle**
  - **Rapid, open, iterative; engage user/test early**
- **Enhance Systems and Capabilities (AFSPC, AQ, AFMC)**
  - **Cyber Situational Awareness, Battle Damage Assessment, Foreign Military Exploitation**
  - **Simplicity, trust, verification, resilience**
- **Focused, Enabling S&T (AFRL)**
  - **Assure and empower missions**
  - **Enhanced agility & resilience**
  - **Optimize human/machine systems**
  - **Establish foundations of trust**

Cyber Vision 2025
Enduring Principles

- **Least Privilege** – provide only necessary authorities (e.g., white listing, discretionary access control, containment)
- **Balance of Power** – distribution of authority, peer review, two person rule
- **Non-Interference** – technical (multilevel) and operational (coord/sychronize)
- **Minimization** – limit attack surface, limit dependencies, reduce capability to essentials
- **Simplification** – allow only necessary complexity, employ standards (interfaces/controls)
- **Survivability** – fitness/readiness, awareness, anticipation, speed (responsiveness), agility (e.g., flexibility/ maneuver), and evolvability
- **Resilience** – robustness (e.g., redundancy), diversity, active defense, rapid reconstitution
- **Optimization** – offense/defense, human & machine intelligence, cost/benefit
- **Asymmetry** – maximize adversary cost/risk/uncertainty; maximize friendly benefit/assurance/efficiency

Cyber S&T Desired Outcomes and Focus Across Air, Space, Cyber, C2 and ISR

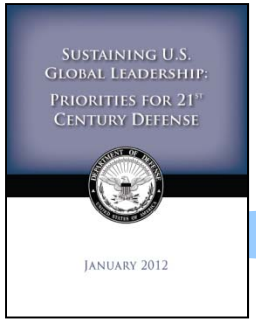
Technology Leader (L), Follower (F), Watcher (W)

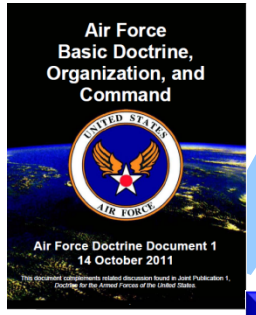
Primary
Secondary
Tertiary

Area	Near (F12-FY15)	Mid (FY16-20)	Far (FY21-25)
Assure and Empower the Mission	• Semi-Automated Mission Mapping and Anomaly Resolution for Cyber SA (L) • Secure Communication (L) • Access and D5[1] Cyber Effects (L/F) [1] D5 = Degrade, Deceive, Destroy Deny, Disrupt	• Real-time AFNET SA & C2 (L) • Cyber Mission Verification and Assurance Across Sensors/ Platforms • Survivable C3 (L) • Advanced Access, D5 Effects (L/F)	• Autonomous Cyber Mission Assurance/ Management (L) • Predictable Cyber Effects on Mission Systems (L)
Enhance Agility and Resilience	• Fractionated, Morphable , Reconstituting Architectures (L) • Cyber Maneuver (L) • Intelligent Mix of GOTS/COTS (F)	• Online Vulnerability Identification and Adaptation (F) • Resilient Virtualization (F)	• Autonomous, Secure, Agile Composable CyberPhys Systs (L) • Cognitive Comm/Networks (agile, reconfigure, self heal) (L)
Optimize Human-Machine Systems	• Operator Selection (e.g., traits, methods) (L/F) • Operator Measurement (stress, cognition, perf., trust) (L) • Adversarial/Social Modeling (L)	• Automated Individual Performance Assessment and Training (L) • Initial Augmented Cognition (L) • Auto Cyber Battle Damage Assess) (L	• Intent/Behavior Detection and Forecasting (L) • Human-Machine Perf Optimize (L) • Neuroscience based brain computer interfaces (L/F)
Foundations of Trust	• Measurement, Vulnerability Model/Analysis, & Verification (L) • Real-Time Cyber Reverse Engineering (L/F) • Software Anti-Tamper (L) • Secure Virtualization (F)	• Information Integrity V&V • Quantum Communication (L) • Root of Trust for Cyber C2 (L) • Embedded Anti-Tamper (F) • Semi Autonomous Supply Chain Assurance (F)	• Quantum Methods for V&V, Trust, and Vulnerability Assessment (F) • Provable Mission Assurance in Contested Domains (L)

Global Horizons
Study Methodology

STRATEGY

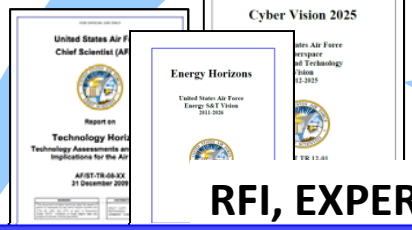




REQUIREMENTS AND PLANS

COCOM and MAJCOM Requirements

CFMPs, STIPLs



Global Horizons

United States Air Force
Global S&T Vision
2013-2027

AF/ST TR 13-01
21 June 2013

Independent Senior Expert Review

Global Threats and Opportunities

CORE FUNCTION | **GLOBAL SECTOR**

Air	Trans
Space	Mfg
Cyber	Comm/IT
C2	Energy
ISR	Health
Support	Ed/Train

Enabling S&T

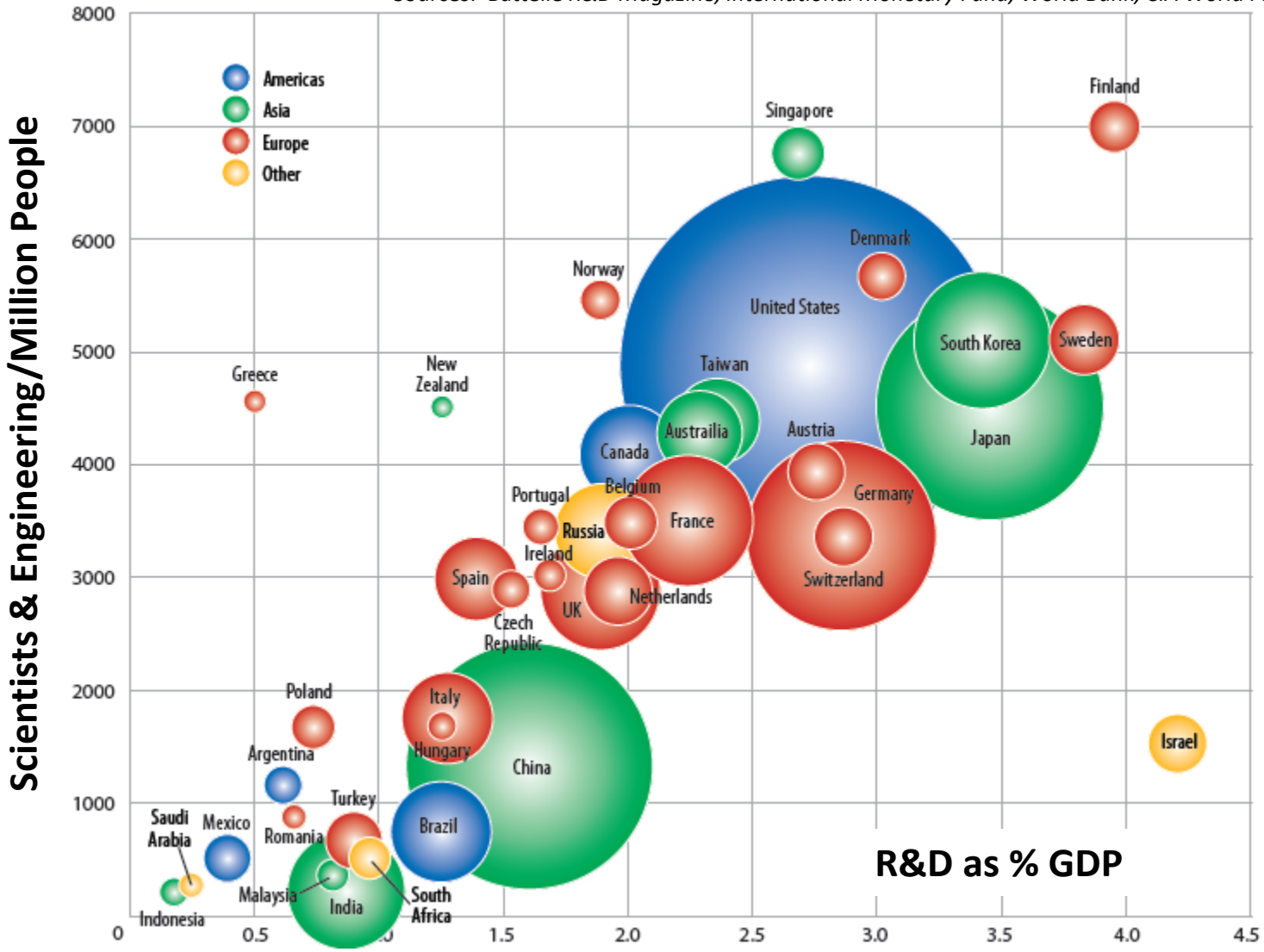
RFI, EXPERT SUMMITS **GLOBAL PRIVATE SECTORS**

Global Vigilance, Reach and Power dependent upon contested Global Domains and Globalized Industrial Sectors

Global R&D (2011)

Size of circle is relative amount of Annual R&D

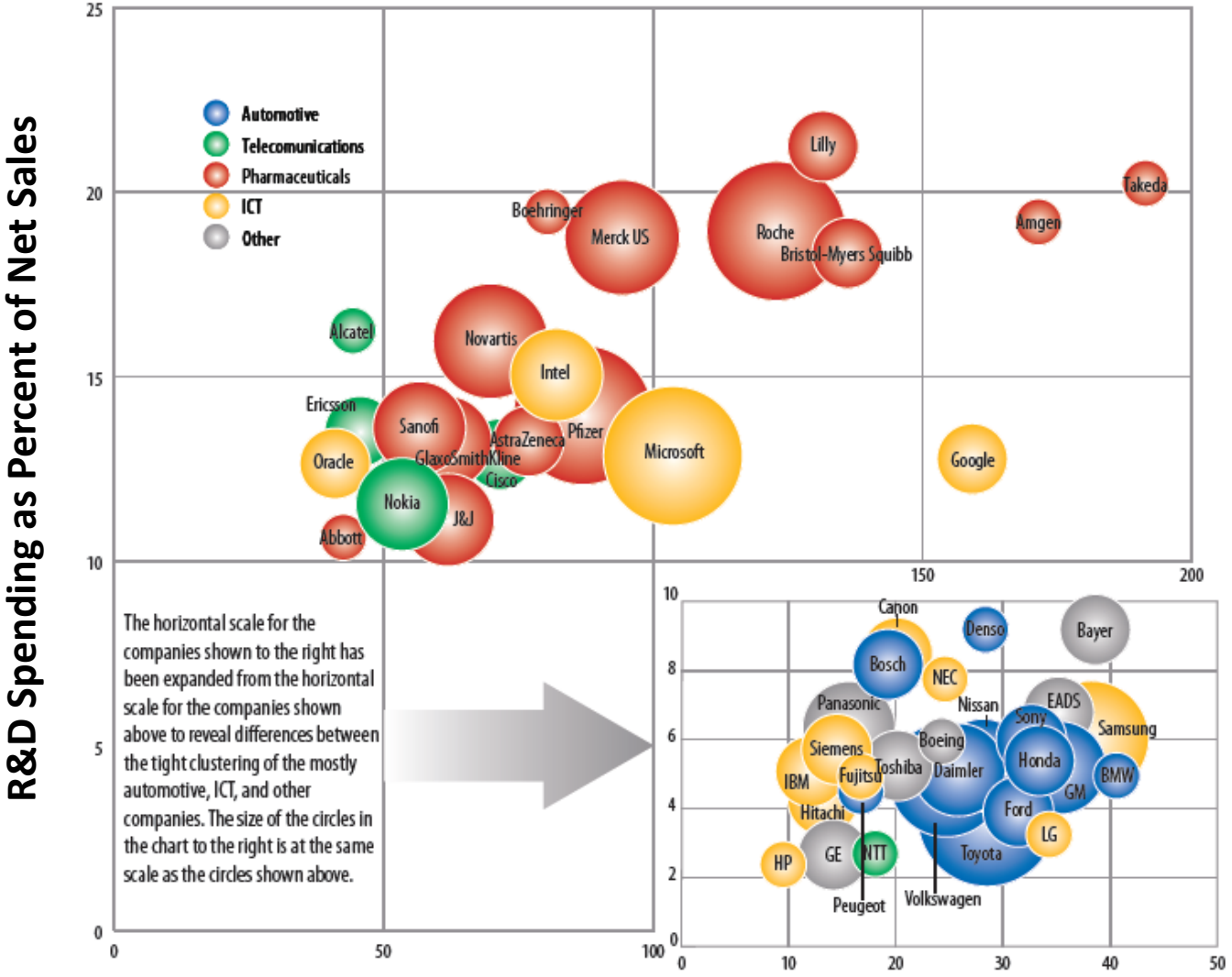
Sources: Battelle *R&D Magazine, International Monetary Fund, World Bank, CIA World Factbook, OECD*



Industrial R&D (2010)

Size of circle is relative amount of Annual R&D

Source: Battelle R&D Magazine



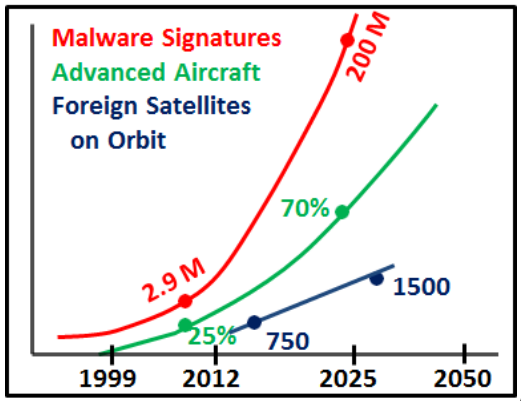
tinyurl.com/AFGlobalHorizons

Air Force Global Horizons

Sustained global advantage that ensures Global Vigilance, Global Reach and Global Power in, through and from air, space and cyberspace to support joint and coalition operations.

Findings

- **Constraints compel efficiency/focus**
- ***Technology Horizons, Energy Horizons*** **and** ***Cyber Vision 2025*** **valid and key**
- **Global commons will be increasingly contested, congested, and competitive**
- **Opportunity to leverage $1.4 trillion global industry R&D – essential to sustaining edge**
- **Supply of educated talent will be constrained and contested**



Recommendations

- **Enhance global S&T vigilance** (NASIC, AFRL/AFOSR, AF/A2, AFISRA)
- **Focus AF S&T on game changers and revolutionary CONOPS** (OPRs: AFRL, MAJCOMs):
  - Trusted and resilient cyberspace, assured PNT (e.g., cold atoms), hypersonics and DE weapons, bio-inspired computation, adv. materials and manuf, personalized health
- **Employ agile and innovative acquisition approaches; Foster partnerships; Shape doctrine, policy, and processes for agility, speed, and cost** (SAF/AQ, AFMC, AFRL)
- **Leverage global industrial investments and partnerships** (SAF/IA, AFMC, AFRL/AFOSR, MAJCOMS)
- **Inspire and focus STEM workforce** (AF/A1, SAF/AQ, AETC, USAFA)

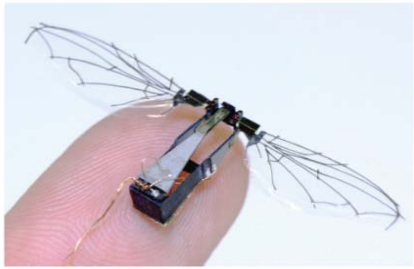
Advancing RPA Roles and Capabilities

- Beyond traditional surveillance and kinetic strike roles
  - Humanitarian relief
  - Homeland security
  - Civilian employment
- Advancing vectors
  - Endurance
  - ISR – coverage, accuracy, diversity
  - On board processing
  - Autonomy
  - Distributed/Cooperative
  - Survivable – Stealth, EW
  - In-flight automated refueling
  - Directed energy (laser and HPM)







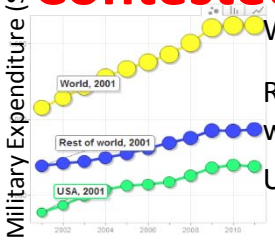



Intelligence Surveillance and Reconnaissance (ISR), Electronic warfare (EW), High Powered Microwave (HMP)

16

Air Challenges and Opportunities

Contested



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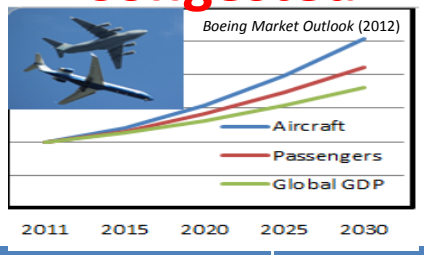


Constrained

Maturing affordable game changing S&T across the Air Domain allows us to remain ahead of near-peer threats, operate with efficiency and impunity in A2AD environments, and evolve Air Doctrine with new technologies.

Theme	Near (FY13-17)	Mid (FY18–22)	Far (FY23–27)
High Speed Systems/Directed Energy	Weapons (L) High Power Microwave missile (L) Target identification (pulsed lasers) (L)	***High Speed Systems*** ISR platforms (L) ***Directed Energy*** Mounted a/c self protect (CW electric lasers) (L)	Reusable, responsive platforms (L) Integrated a/c self protect; speed-of-light strike (L)
Autonomy/Distributed Decision Making/ Fractionated Systems	Distributed mission planning (L) Sense and avoid (L) Automat/Autonomous formation flight (L)	***C2 and Communications*** Automated terminal area operations (F*) ***Platform and Operations*** Cooperative and autonomous control (L)	Human/machine cognitive communications (F*) Human/machine teaming (F*)
Advanced Aircraft Adaptive Architecture	Enhanced analysis for V&V (F*) Certification of composite structures (F*) Large composite structures (F*)	***Processes*** System-of-system certification (F*) ***Products*** Modular aircraft architectures (F*) Plug-and-play avionic interface (L)	Automated assembly and quality assurance (F*) Universal weapon system interface (L)
Small Munitions/Long Range Missiles	Cooperative control & selectable effects (L) Self-realizing and adaptive guidance (L)	***Small munitions*** Multi-purpose, multi-mode effects packages (L) ***Long Range Missiles*** Sensor/seekers, apertures, payload, guidance (L)	Optimized internal carry design (L) Real-time adaptive software (L)
Energy Efficient Aircraft and Propulsion Design	ADVENT/AETD/ESSP (L) Thermal management/adaptive cycles (F*) Laminar flow control (F*) Conformal antennae (F*)	***Propulsion and Power*** HEETE (L) On-demand integrated subsystems (L) ***Airframe/Aerodynamics*** Lightweight, unitized structure (F*) Adaptive structure and active flow control (F*)	Adaptive HEETE (L) Hybrid systems/distributed propulsion (F*) Supersonic tailless designs (L) N+1 generation efficient aircraft configurations (F*)

* AF should follow industry, unless a specific AF application

Cold-Atom Inertial Navigation Systems
GPS-Denied Environments

Position Uncertainty for 3 Scenarios

36 h loiter

20,000 m

20 m

1-3 m

Flight half-way around world

1000 m

1-3 m

1 m

Ballistic missile flight

500 m

1-3 m

0.1 m

GPS

Cold Atom INS

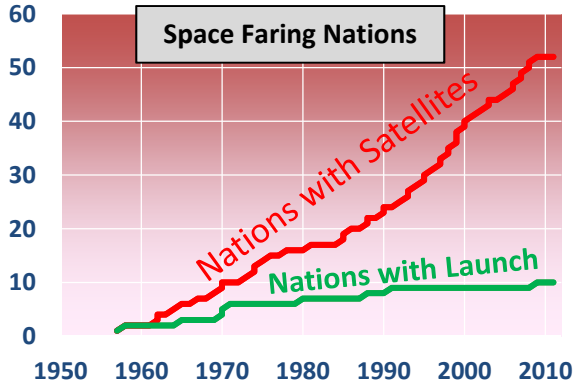
Laser-based INS

Cold atom INS: potentially provide orders of magnitude better performance than laser-based INS, and accuracy comparable to GPS for GPS-denied environments

Space Challenges and Opportunities

3. Falcon7 NanoSat

Competitive



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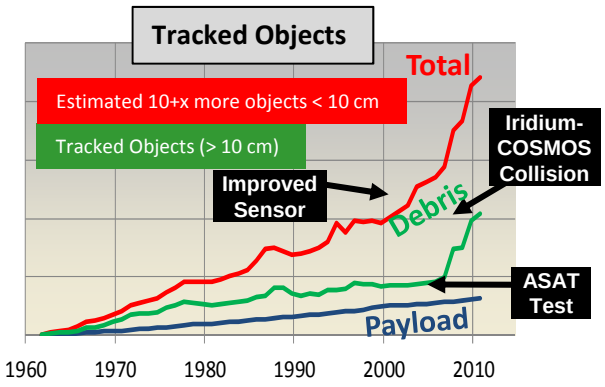

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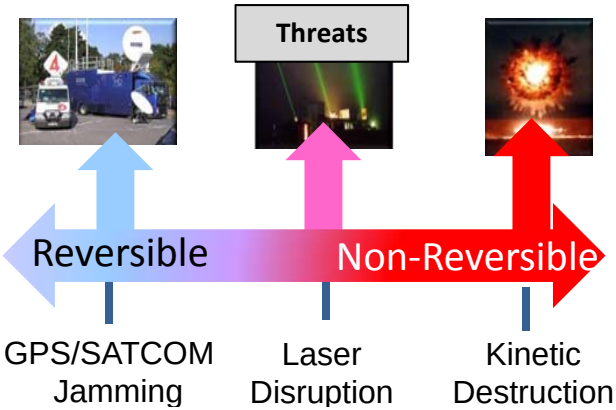


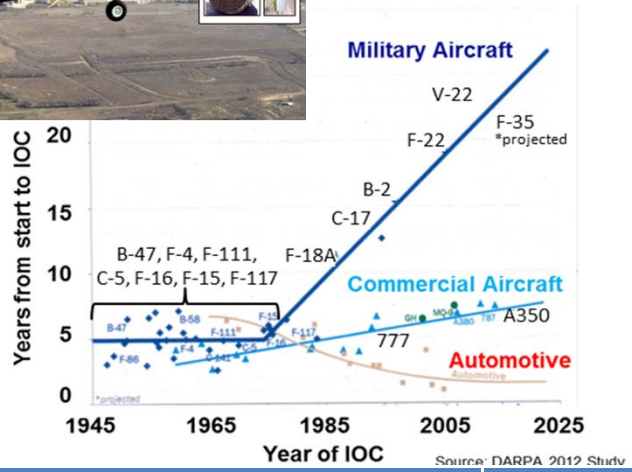
Area	Near (FY13-17)	Mid (FY18-22)	Far (FY23-27)
Disaggregation	• Demonstrate Disaggregation (L)	• Demo Fractionation (L) • NavSat (L) • Cold atom INS (L)	• Microsatellites (F) as canonical architecture • Persistent SSA (L)
Inexpensive Launch	• 100-kg to LEO for $1-3M (W)	• GEO and LEO commodity launch (L)	• Launch raw materials (L?) • Launch deployables (L)
Space Cyber	• Testbeds (L)	• Space-HAIPE (F)	• Agile and Resilient by Design (W)
Architectures	• Deployable antennas (L) • Open standards (L)	• Synthetic apertures (F) • Open Arch (L)	• Composable constellations (L) • Quantum computing (F)
Communications	• AEHF (L), V/W band (L)	• Laser communications (L)	
Manufacturing	• Radiation-hard (L)	• Additive manufacturing (F)	• Build in space (L?)

SSA=Space Situational Awareness; AEHF = Advanced Extremely High Frequency; HAIPE == High Assurance Internet Protocol Encryptor; QKD=Quantum Key Distribution

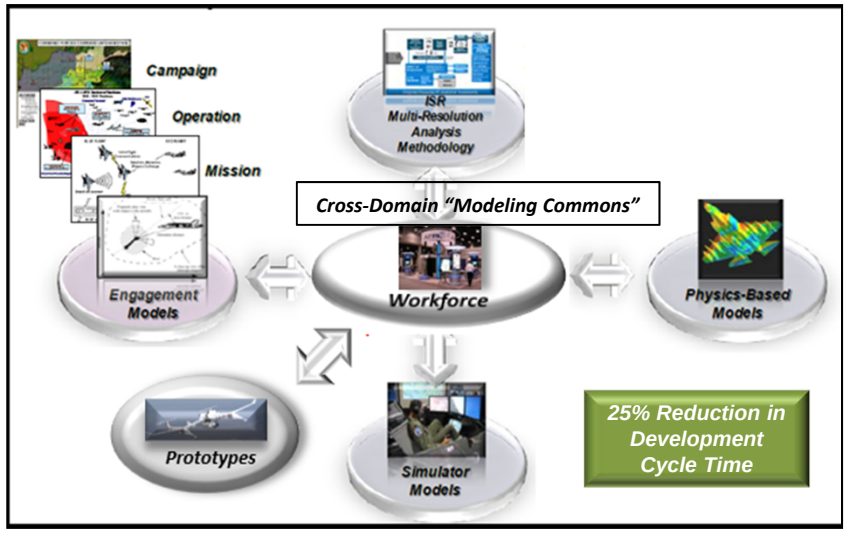
Mission Support Challenges and Opportunities

Technology Integration Time

Increased competition for technical talent

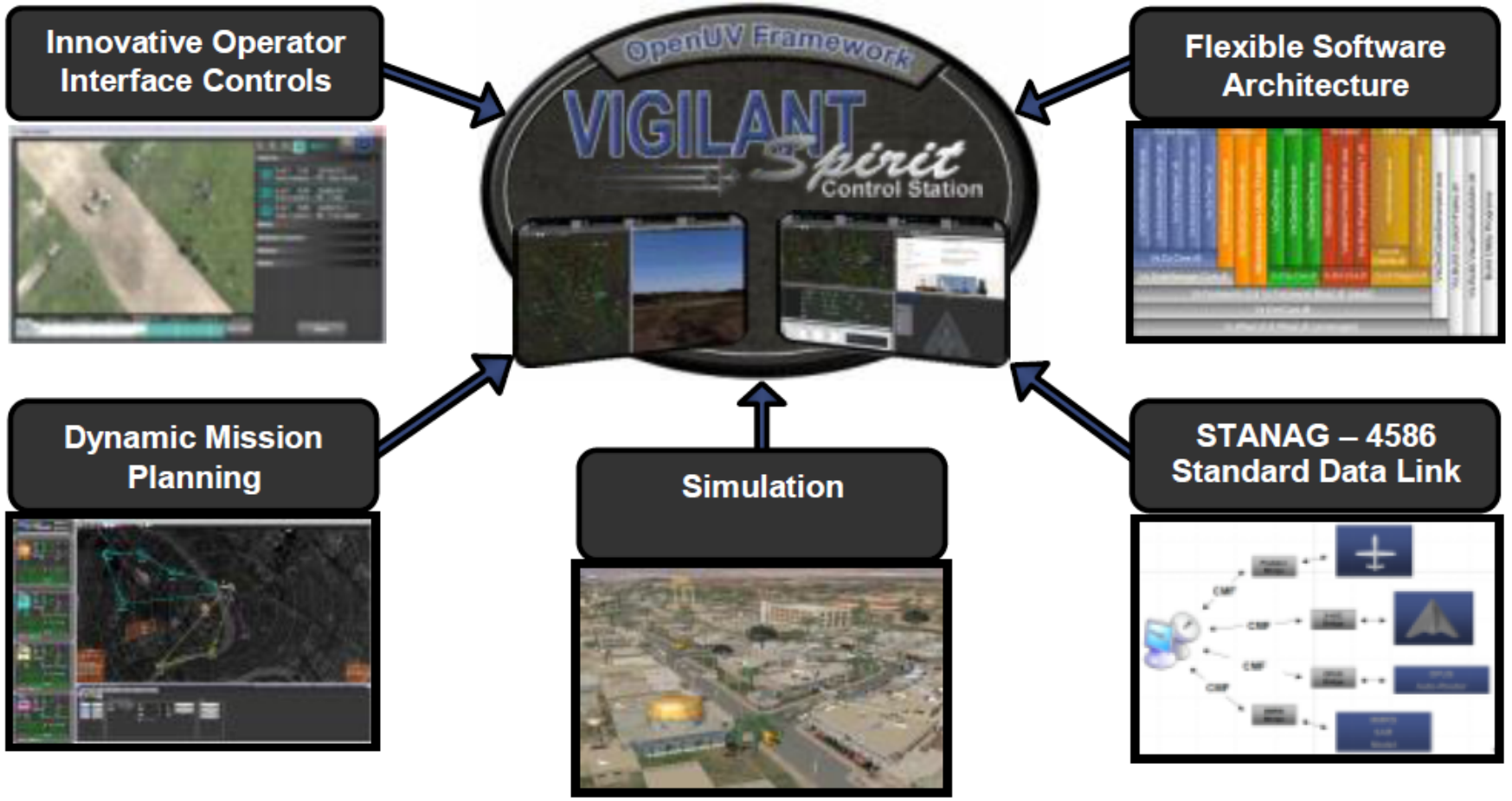


Agile Development Rapid Experimentation



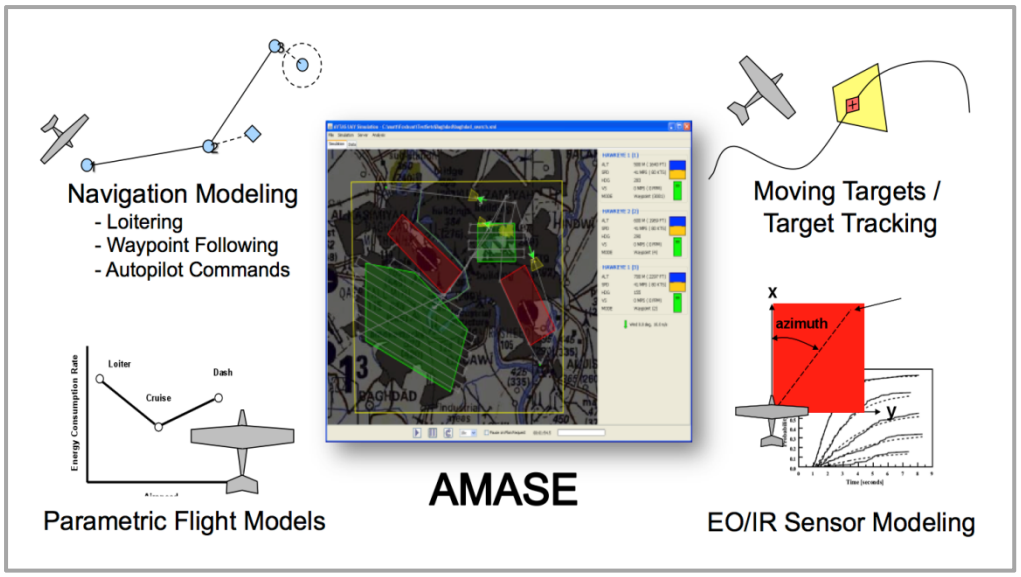
Area	Near (FY13-17)	Mid (FY18-22)	Far (FY23-27)
Digital Design Tools	• Optimized digital design tools (L) • Engage industry (F)	• System of System trades (L) • Open arch w/built-in trust (F) • Digital Thread expanded to exercises, CONOPS, training environment (L)	• Tightly integrated digital thread and prototyping process to enable agile development and quickly field scalable capabilities (L)
Prototyping	• Prototype program demonstration (L) • Open challenges (F)	• End-to-end prototype centers w/joint user & industry experimentation (L)	
Agile Workforce	• Expand flexible hiring & management practices – Lab Demo (F)	• Develop workforce skills through prototyping (F)	• Agile workforce to respond to rapidly emerging technical challenges (L)

Vigilant Spirit Control Station (VSCS)

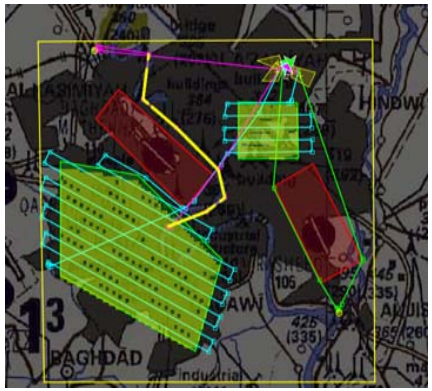


AMASE: AFRL's AVTAS Multi-Agent Simulator to Develop Control Algorithms

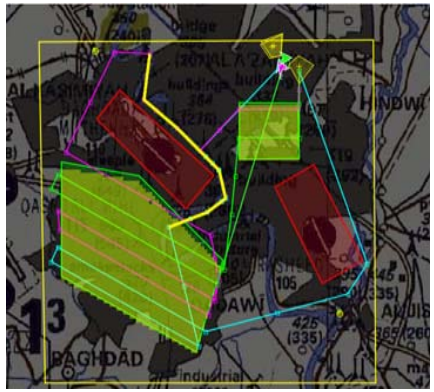
- **AFRL Desktop simulation environment to accelerate RPA cooperative control studies**
- **Allows effectiveness of control algorithms to be quantitatively assessed and compared; Used for RPAs flown in Talisman Saber 2009**
- **Example compares control laws in mission with multiple areas and no-enter zones with heterogeneous RPAs; too complex for intuition**



Comparison of two cooperative RPA control systems



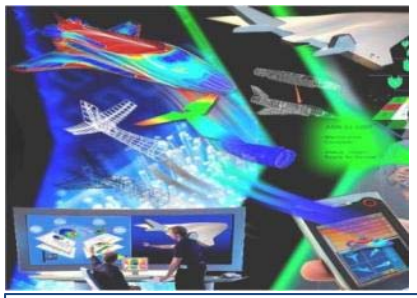
93% areas covered
94 min. mission time
30% RPA energy used



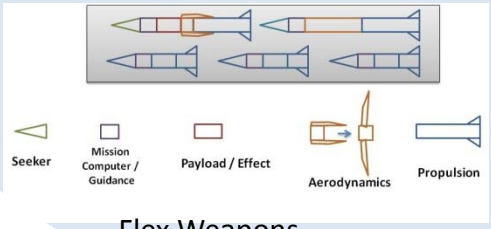
100% areas covered
57 min. mission time
15% RPA energy used

Agile Manufacturing for Rapid & Affordable Fielding

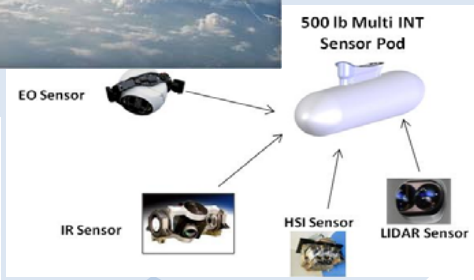
Affordable Capability…… New Systems /sub-systems



Networked Collaborative Design: 60% less time

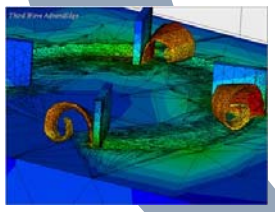


Flex Weapons

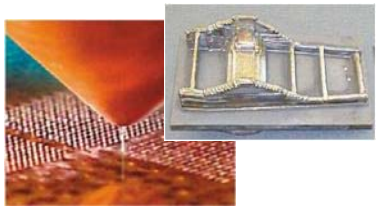


Open Architecture ISR Pod

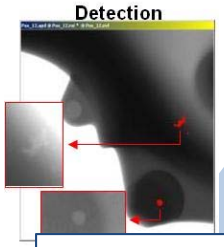
From S&T to the Field: Faster @ Less Cost



Model-Based/ Virtual Mfg: 50% less time



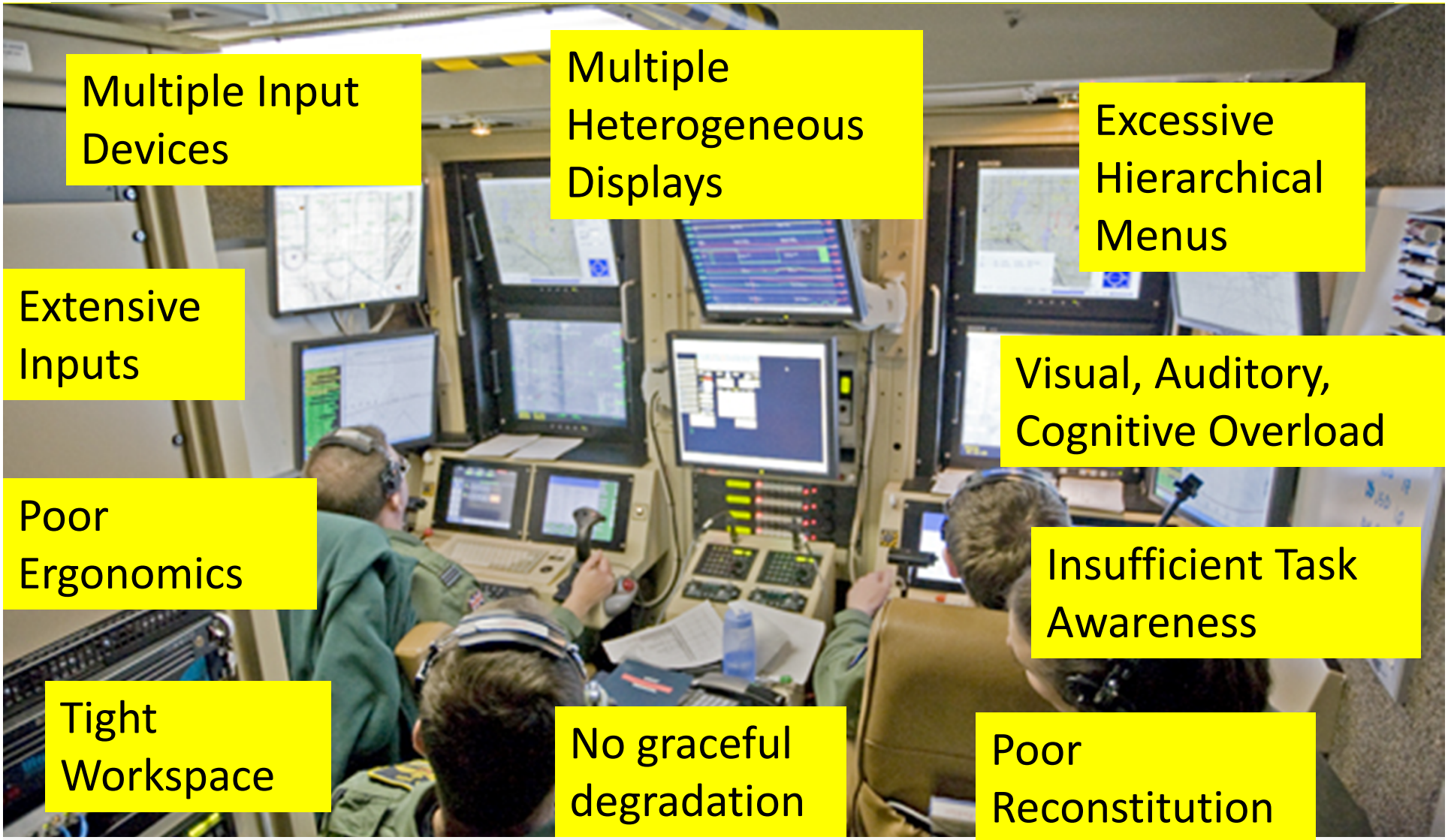
Direct Digital & Additive Mfg: Small lot production



Auto/Digital Inspection: 20% less time

Automated Assembly: 30% less time

Human Centered Aviation

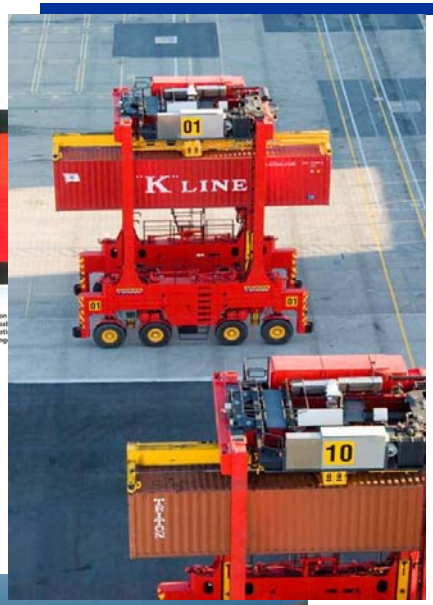


Zacharias, G. and Maybury, M. 7 July 2010. Operating Next-Generation Remotely Piloted Aircraft for Irregular Warfare, Washington DC: Air Force Scientific Advisory Board. https://www.sab.hq.af.mil/TORs/2010/Abstract_UIW.pdf

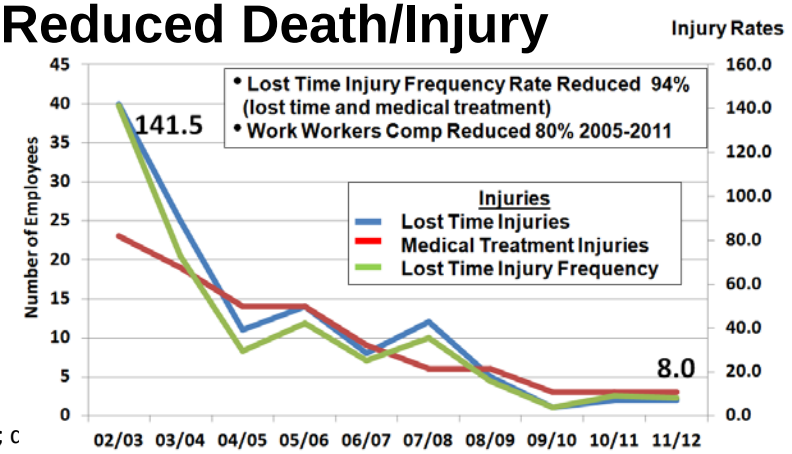
Transportation Autonomy

Global Shipping at Brisbane Terminal, AU

5. Brisbane



- **-27% Labor, -40% Fuel**
  - **'98: 120k lifts,122 perms, 3 cranes, 500K TEU**
  - **'12: 320k lifts, 83 perms, 5 cranes, 800K TEU**
- **Increased Precision (MM radar, 2cm)**
- **+66% Speed; -70% Maintenance**
- **Improved Cost, Use of Capital**
  - **Labor to revenue down 50% to 21%**
  - **+10% to automate, 1.5 -2yr payback**
- **Reduced Death/Injury**



See video at: tinyurl.com/brisbane-port-autonomy

Degrees and Levels of Autonomy

e.g., establish campaign objectives	e.g., plan/refine alternative campaign courses of action (COAs)	e.g., select/refine alternative machine derived COAs	beyond current machine representation, reasoning, and learning
e.g., search and rescue planning; pilot-controller coordination	e.g., mission planning, route planning, forensic analysis of sensor data	e.g., automated contingency plans, air drop execution, course of action assessment	e.g., sense and avoid, autosafing of satellites
e.g., pre-flight aircraft fuselage inspection	e.g., human review of auto "cued" targets	e.g., autopilot management, satellite station keeping	e.g., sensing, intrusion detection using firewall rules
Manual	***Mixed, "in the loop"***	***Supervised, "on the loop"***	***Autonomous***

Campaign

Mission

Task

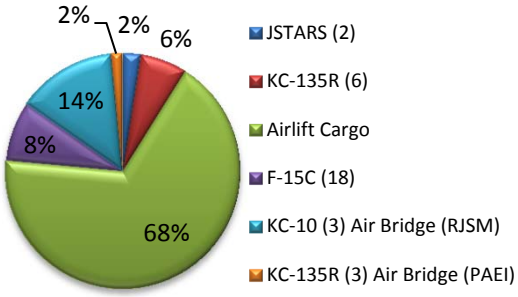
Levels of Autonomy

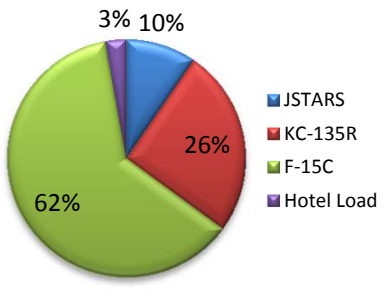
Degree of Autonomy

Source: Maybury, M. 2012. Usability in Defense Systems: Examples from Aviation. In Murray, D. and Buie, E. (eds). Usability and User Experience in Government Systems: Designing for Citizens and Public Servants. Elsevier Press/ Morgan Kaufmann, p. 97-108

Logistics and Transportation Challenges and Opportunities

Large Logistics Tail





Fully Burdened Cost of Logistics

Theme	Near (FY13-17)	Mid (FY18-22)	Far (FY23-27)
Automation	• Robotic warehousing (F) • Automation integration into aerial ports and flightline servicing (L)	• Robotic shipping/handling (F) • Integrated automated shipping (F) • Automated sensors and base protection (L)	• Aircrew optional airlift and refueling (F*)
On-Site Production and Manufacturing	• Additive manufacturing (W) • 3D Printing (W) • Multi-material recycling (F)	• Certification of parts produced by additive manufacturing (F*)	• On-Site manufacturing for deployed locations (L)
Logistics Efficiency	• Compatibility with Next Gen ATC (F*) • Logistics Situational Awareness (F*)	• Energy efficient aircraft and propulsion (L)	
Precision Delivery to Austere/Remote Bases	• Precision airdrop (L) • Affordable wind profiling system (L) • Air to ground communications (L)	• Efficient high power lift (L) • Ground-based laser for base defense (L)	• Autonomous ground delivery systems (F*) • Airships (F) • Cargo UAS (F*)

Partnership and Focus

COCOMs

Intelligence Community

Army, Navy, Marines
Land and Maritime cyber

National Labs FFRDCs

U.S. AIR FORCE
Air, Space, C2ISR

Federal Research
DARPA, NSF, FAA, OSTP, NASA , NIST

Academia

Industry & Consortia
(e.g., DIB Pilot)

Critical Infrastructure
DHS, EPRI, Utilities

International

Air Force will leverage capabilities and investments of our partners and focus S&T investment on Air Force core functions

Global Horizons Leads

- **Core Function Teams**
  - Threat: Mr. Gary O'Connell (NASIC), Maj Gen Jim Keffer (A2), Col Matthew Hurley (AF/A2DD)
  - Air: Dr. Don Erbschloe (AMC), Dr. Dave Robie (ACC), Doug Bowers (AFRL/RQ), Bill Harrison (AFRL/RQ), Dr. Bob Peterkin (AFRL/RD), Dr. Mikel Miller (AFRL/RW), Dr. Kamal Jabbour (AFRL/RI), Dr. Brian Kent (AFRL/RY)
  - Space: Dr. Doug Beason (AFSPC/ST), Dr. Jim Riker (AFRL/RV), Col Scott Beidleman (SMC/XR), Dr. Roberta Ewart (SMC/XR), Dr Alan Weston (NASA)
  - Cyber: George Duchak/Dr. Rich Linderman (AFRL/RI), Dr. Doug Beason (AFSPC), Mr. Arthur Wachdorf (24AF), Frank Konieczny (SAF/A6 CTO), Mr. Mike Kretzer (688th), Steve Schneider (AFRL/RY), Dr. Rusty Baldwin (AFIT/ENGE)
  - C2 and ISR: Dr. Steven K. Rogers (AFRL/RY/RI), Dr. Terry Wilson (RY), Mr. Stan Newberry (AFC2IC), Dr. Chris Yeaw (AFGSC/ST), Jeff Eggers (AF/A2), Keith Hoffman (NASIC), Mr. Bill Marion (ACC); Dr. Byron Knight (NRO/SED)
  - Mission Support (Acquisition, T&E, Workforce): Dr. David Walker (SAF/AQR), Susan Thornton (AFMC/EN), Col Derek Abeyta (AF/TE), Maj Mike Dunlavy (SAF/AQR), Lt Col Dan Ward (AFLCMC), Ed Kraft (AEDC/CZ), Dr. Alok Das (AFRL/RY)
  - Enabling Technology: Dr. Jennifer Ricklin (AFRL), Dr. Chuck Matson (AFRL/AFOSR), Dr. Pat Carrick (AFRL/AFOSR)
- **Global Sector Teams**
  - Manufacturing and Materials – Dr. Barry Farmer (AFRL/RX), Doug Bowers (AFRL/RQ), Dr. Mikel Miller (AFRL/RW), Col Keith Bearden (AFLCMC/XZ), Rollie Dutton (AFRL/RXM)
  - Transportation and Logistics – Don Erbschloe (AMC), Steven Hofmann (A3O, Next Gen)
  - Energy, Utilities & Mining – Dr. Kevin Geiss (SAF/IE), Bill Harrison (AFRL/RZ), Bob Peterkin (AFRL/RD)
  - Health Care & Pharma – Dr. Morley Stone (AFRL/RH), Dr. Deb Niemeyer (59 MDW/ST), Lt Gen Tom Travis (AF/SG); Col Randy Ashmore (AFMSA/SG5)
  - Communications, Information Technology, Financial Services - George Duchak/Dr. Rich Linderman (AFRL/RI), Dr. Doug Beason (AFSPC), Dr. Kamal Jabbour (AFRL/RI), Dr. Paul Antonik (AFRL/RI), Dr. Rob Gold (ASD R&E)
  - Education and Training – Dr. Bruce Murphy (AU/VP Academic Affairs), Dr. Todd Stewart (AFIT), Dr. Nathaniel Davis (AFIT), Jack Blackhurst/Dr. Morley Stone (AFRL/RH), John Geis (AU/AFRI), Dr. Steven Hansen (AU), BGen Scott Vander Hamm/Craig Seeber (AETC/A5/8/9A), Lt Col Chris Bohn (AU/Spaatz Center), Dr. Aaron Byerley, (USAFA)

Senior Independent Expert Review Group (SIERG)

Air	Space	Cyber	C2ISR	Msn Support	S&T, Threat, …
Trans	**Man/Mat**	**Comm/IT/Financial**	**Energy**	**Ed & Train**	**Health**
Dr Mark Lewis, IDA	*Dr Mike Yarymovych, Sarasota Space*	Prof Ed Feigenbaum, Stanford Gil Vega, DoE Andrew Makridis, CIA Glenn Gafney, CIA	Prof. Alex Levis, GMU Dr Donna Rhodes, MIT SEAri Dr Mica Endsley, SA Technologies	Dr Steve Walker, DARPA Norm Augustine Heidi Shyu, ASA ALT Mr John Gilligan	Gen (Ret) Mike Carns Prof Werner Dahm, ASU Lee Jameson, NSF Charles Bouldin, NSF Lauren Van Wazer, OSTP Tomas Vagoun, NITRD
Natalie Crawford, RAND	*Dr Rami Razouk, Aerospace*	Dr. Paul Nielsen, CMU/SEI Dr. Steve Burssolari, MIT LL Alan Bernard, MIT LL	Al Grasso, MITRE Ralph Semmel, JHU-APL	Jim Gosler, Sandia Giorgio Bertoli, Army	Konrad Vesey, IARPA Stan Chincheck, NRL Dr. Walter Jones, ONR
Lt Gen (Ret) George Muellner Dr Jaiwon Shin, NASA	*Dr Eli Neiwood, MIT LL* *Dr David Miller, MIT* Don Kerr Keith Hall	Gen (Ret) Mike Hayden Lt Gen (Ret) Ken Minihan Paul Laugesen, NSA/TAO Dr Yul Williams, NSA/CSS TOC Dr Mike Wertheimer, DoD Dr Boyd Livingston, DoD Lt Col Marion Grant, USCYBERCOM/J9	VADM (Ret) Mike McConnell Lt Gen (Ret) David Deptula Dr Jim Hendler, RPI Ray Haller, MITRE Dr Steve Cross, Georgia Tech	Al Shaffer, OSD (R&E) Greg Smith, NGA Ben Steinberg, DoE Landon Derentz (DoE) Gen (Ret) Duncan McNabb	Gen (Ret) Jim McCarthy, USAFA Dr Peter Friedland Prof Pat Winston, MIT Terry Jaggers, NAS Richard Matlock, MDA
Robert Osborne, NNSA Dr Tom Hussey	Dr Mason Peck, NASA CTO Brig Gen (Ret) Pete Worden, NASA Matt Linton, NASA ARC-IS	Dr Starnes Walker Larry Schuette, ONR Tim Grance, NIST Dr Steven King, OSD(R&E)	Lt Gen (Ret) Ted Bowlds, Lt Gen (Ret) Robert Elder Lt Gen (Ret) Ken Israel	Dr Tim Persons, GAO Brian Hughes, AT&L Tom Ehrhard, OSD(P)	David Honey, DNI Dr Kathryn Sullivan, NOAA Dr Paul Kaminski, DSB Chair

Former USAF Chief Scientist | Former NRO Director | Former Director NSA, DIA | Former DNI | Former AF CSAF, & VCSAF | *AF SAB EXCOM*

Coalition

Air Vice Marshall Brecht, RAF UK
Simon Kippin, MoD UK
Dr. Brian Hanlon. DSTO, Australia
Dr. Anthony Schellhase, Australia
Mr. Christopher McMillan, Canada
Norbert Weber, German MoD

Video URLs

- Cyber
  - www.youtube.com/watch?v=pm_mZJ7odJU
  - http://www.youtube.com/watch?v=OL2lORXwg2E
- Waverider - *www.youtube.com/watch?v=3_RrFXQViyo*
- FalconSat 7 - *www.youtube.com/watch?v=_ZAM-Lqin3A*
- Additive Manufacturing - www.youtube.com/watch?v=i6Px6RSL9Ac&list=PL606B165D97B7A720
- Brisbane - www.youtube.com/watch?v=hVSGYbaHBsk
- Autonomy: Compilation of perching, self assembly, and nano quadroters: www.youtube.com/watch?v=m2M1gp0MXlQ
  - Perching robotic bird www.youtube.com/watch?v=2QqTcQ1BxIs
  - Autonomy: Swarm of Nano quadrotors – fly in formation, navigate (1 min 42s) www.youtube.com/watch?v=6lCUGPixEnk
- Kiva www.youtube.com/watch?v=6KRjuuEVEZs www.youtube.com/watch?v=lWsMdN7HMuA
- Humanitarian/Medevac vision: www.youtube.com/watch?v=2AQ65I9FUPA

7. RPA, GCS